ISOPODS OF FOUR SEAWEEDS IN THE BAY OF ISLANDS, NEW ZEALAND

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Abstract. Isopods of the subtidal macroalgae *Carpophyllum angustifolium, C. maschalocarpum, Xiphophora chondrophylla* and *Plocamium costatum* are described from the Bay of Islands, New Zealand. Isopod diversity is greatest on the carpophyllums but their communities, while stable, differ in composition because of the number of strongly host/habitat specific species. The isopods *Amphoroidea longipes* and *Dynamenella cordiforaminalis* characterise *Carpophyllum angustifolium*, whereas the isopods *Amphoroidea media* and *Dynamenoides decima* are specific to *Carpophyllum maschalocarpum. Dynamenella huttoni* was the codominant species on both *Plocamium costatum* and *Xiphophora chondrophylla*, while *Scutuloidea maculata* was common on all the seaweeds and had highest abundance on the three exposed seaweeds (*Plocamium costatum, Xiphophora chondrophylla* and *Carpophyllum angustifolium*). Exposure and substrate appear to play a part in the habitat preferences of isopod epifaunas.

Subtidal seaweed cover of rocky shores provides important habitats for the development of animal faunas. The contributing factors that shape ecology, including impacts on faunal density, species diversity and community interrelationships, are crudely understood (Morton & Miller 1968). Shoreline ecological studies that include strong reporting of crustacean groups (especially amphipods and isopods) are particularly lacking, even though seaweeds have high densities of these groups and are favourite habitats for collectors and taxonomists. It may be that difficulties in taxonomy alone are a sufficient deterrent. Comment on swimming faunas can also be avoided through the justification that mobility displaces these animals in such a way that they are non-participants of the seaweed fauna.

While Hurley & Jansen (1977) review the taxonomy and distribution of sphaeromatid isopods in the New Zealand region, based on accumulated national collections, their accompanying station lists (derived from those collections) are vague in gaining any ecological appreciation of seaweed/isopod relationships. The foundation to an ecological perspective of this group (Jansen 1971) considers frequency and distribution of 10 isopod species in relation to habitats in varying degrees of exposure. Although this introduces new information linking isopod habitat preference with individual algal species, its restriction to the Sphaeromatidae excludes reporting on other families which are common in seaweed communities. In working with mobile epifauna of brown seaweeds, Taylor & Cole (1994) included isopods, but some of their data are presented without identification to species.

We report on isopods in seaweeds from two stations in the Bay of Islands, New Zealand, over fifteen months. We recognise eight regularly occurring isopod species from three brown seaweeds (*Carpophyllum angustifolium, C. maschalocarpum, Xiphophora chondrophylla*) and one red seaweed (*Plocamium costatum).*

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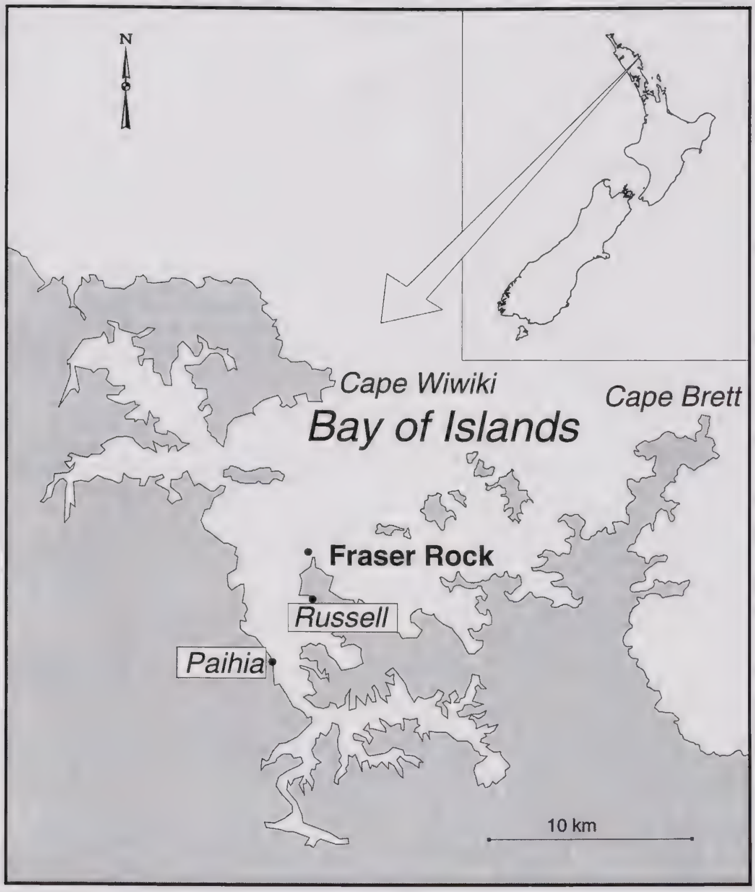

Fig. 1. Locality of Fraser Rock sampling stations, Bay of Islands.

METHODS

Three dominant seaweeds, *Carpophyllum angustifolium* Agardh, 1877, *Xiphophora chondrophylla* (Turner, 1819) and *Plocamium costatum* Agardh, 1841, were gathered from a small rock (35°14.5' S, 174°07.0' E) adjacent to Fraser Rock, Bay of Islands (Fig. 1). This is part of the Tapeka Point reef system and is close to NZOI Stn.981 for which Barnard (1972) reports the gammarid amphipods from seaweed. Because of the underwater profile this rock is exposed to swell and waves regularly throughout the year even though it is partially enclosed by coastline and outer islands. A fourth seaweed *Carpophyllum maschalocarpum* (Turner 1819) was collected from a shallow water, sheltered site c. 200 m SE along the Fraser Rock platform. These sites were sampled on five occasions at intervals (weather dependent) between July 1991 and September 1992.

Seaweeds were collected and the species kept isolated. Samples were gathered by hand, at low tide, by freeing each plant from its holdfast and rapidly transferring it to a large (450 x 850 mm) plastic holding bag. This method was sufficient to entrap mobile animals including shrimps, clingfish and pipefish. About 5 kg wet weight of bulk sample (including drip water) was collected for each seaweed type. Samples were taken ashore and processed immediately.

Wet plants were removed individually and vigorously shaken into another plastic bag of the same dimensions. Animals were decanted from the accumulated drip water and fixed in buffered 3% formaldehyde/glutaraldehyde mix. Plants of the earliest sampling period were examined subsequently for isopods that had not detached, but the process was unwarranted. Putting plants into formalin fixative to dislodge epifaunas (Taylor & Cole 1994) was not found to be as reliable. Isopods, especially *Batedotea elongata* and *Amphoroidea* spp., which attach strongly to the thallus (using opposing grip and suction techniques) were found to die *in situ* rather than to swim away.

Some time later, isopods were separated from the bulk sample, identified and measured with the aid of a stereo-microscope. Voucher specimens are retained within the collections of the Auckland Museum. In identifying the relationships of association between isopods and seaweed environments a detrended correspondence analysis, DECORANA (Ter Braak 1985) was applied to the data.

RESULTS

The isopod fauna of seaweeds at the Tapeka site contains at least 22 species (Appendix 1), but deficiencies are recognised in the taxonomy of New Zealand species of the genera *Astacilla, Limnoria, Paranthura* and *Scutuloidea*. A predominance of seaweed isopods, however, are from the Sphaeromatidae, a feature that is expected because of their well known general distribution in littoral-sublittoral zones. In several instances a species was recorded only once and/or in numbers fewer than 10 (eg. *Dynamenella condita, D. insula, D. mortenseni*); these are not treated further as they have little impact on the community structure. In addition, we have set aside *Limnoria* sp. which is normally an excavator or burrower of the stipe and holdfast of *Carpophyllum.* Its reporting therefore, as thallus epifauna is accidental. In effect only eight isopod species, *Amphoroidea longipes, A. media, Batedotea elongata, Dynamenella cordiforaminalis, D. huttoni, Dynamenoides decima, Paranthura* sp. and *Scutuloidea maculata* occur consistently.

SEAWEED ASSOCIATIONS

A detrended correspondence analysis (DECORANA), using the programme CANOCO (Te Braak 1985), was used to summarise the data for the eight principal species. A two dimensional plot of the analysis is given in Fig. 2. Two clear groups emerge; one consisting of the seaweed *Carpophyllum maschalocarpum* and the other containing the three seaweeds *Xiphophora chondrophylla, Plocamium costatum* and *Carpophyllum angustifolium.* These two groups also correspond to a difference in exposure – *Carpophyllum maschalocarpum* is from a sheltered site and the other three are from exposed sites. Within the group of three seaweeds there is an additional split of *Carpophyllum angustifolium* from the other two. It is interesting to note that the two carpophyllums are the least similar.

Plocamium costatum

The *Plocamium* association (Fig. 2) shows a grouping influenced by *Dynamenella huttoni, Amphoroidea longipes*, *Scutuloidea maculata* and *Dynamenella cordiforaminalis*. The dominant species was *Scutuloidea maculata*, which showed a peak in abundance in the March 1992 sample. *Dynamenella huttoni* was the subdominant species (Fig. 3) and also showed a peak abundance in the March 1992 sample, but not in the numbers shown by *Scutuloidea maculata.* Six other species were recorded here but in numbers less than 10 for the entire sampling period. The sample for March 1992 gives the greatest abundance, both in numbers and species diversity (Appendix 1).

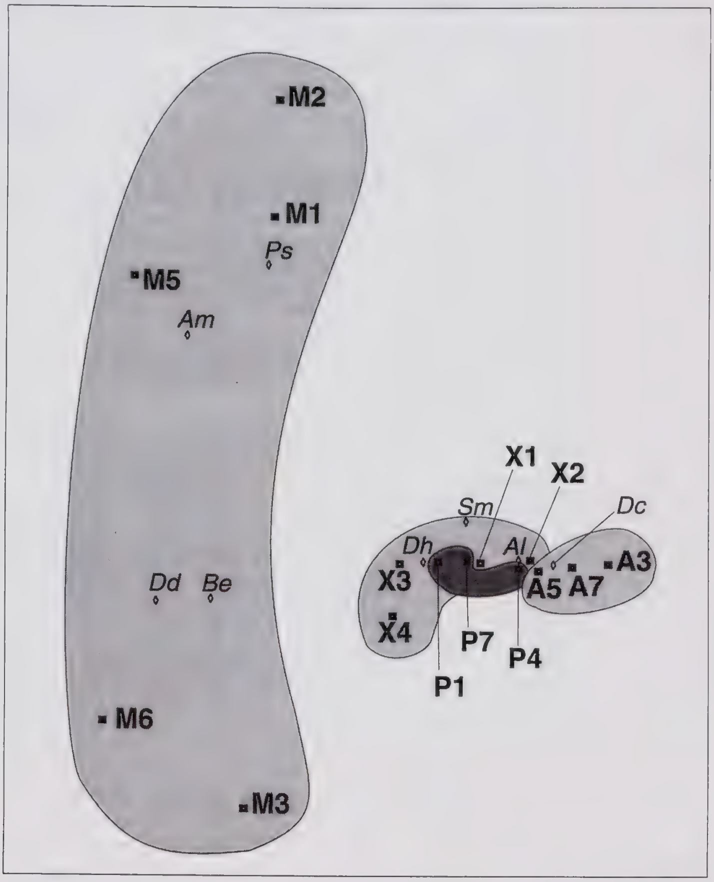

Fig. 2. A two-dimensional detrended correspondence analysis (DECORANA) plot of the principal isopod species on four seaweed substrates. A = *Carpophyllum angustifolium*, M = *Carpophyllum maschalocarpum*, X = *Xiphophora chondrophylla*, P = *Plocamium costatum*, Al = *Amphoroidea longipes*, Am = *Amphoroidea media*, Be = *Batedotea elongatus*, Dc = *Dynamenella cordiforaminalis*, Dd = *Dynamenoides decima*, Dh = *Dynamenella huttoni*, Ps = *Paranthura* sp., Sm = *Scutuloidea maculata*. Numbers 1 - 7 beside the letters A, M, X and P indicate sampling times as shown in Appendix 1.

Xiphophora chondrophylla

The *Xiphophora* association (Fig. 2) is influenced by *Dynamenella huttoni*, *Scutuloidea maculata* and *Amphoroidea longipes*. Two species *Scutuloidea maculata* and *Dynamenella huttoni* were codominant for all samples with *Amphoroidea longipes* also present in significant numbers (Fig. 3). Peak abundances again occurred in the March 1992 sample for these three species. Five other species were recorded, with two of those in numbers less than 10. The March 1992 sample again gives the greatest species diversity and specimen numbers (Appendix 1).

Carpophyllum angustifolium

The *C. angustifolium* association (Fig. 2) is strongly influenced by *Dynamenella cordiforaminalis*, *Scutuloidea maculata* and *Amphoroidea longipes*. The dominant species was *Scutuloidea maculata* which had a high abundance in the April 1992 sample and was common in the other samples. *Dynamenella cordiforaminalis* was the subdominant species

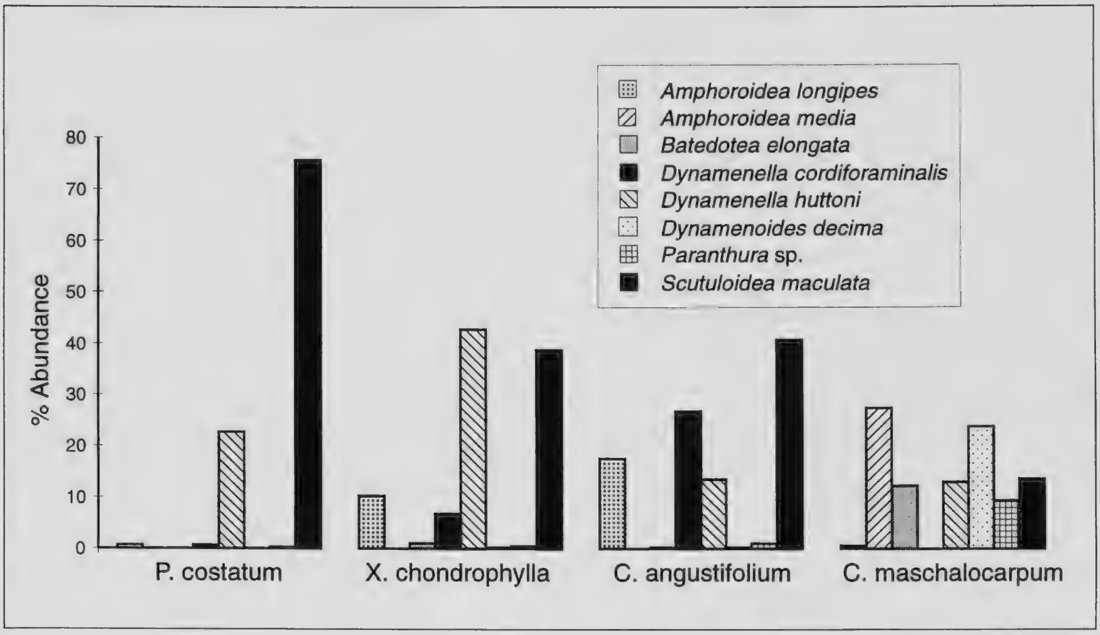

Fig. 3. Percentage abundance of principal isopod species from accumulated totals of samplings, over fifteen months, segregated by seaweed type.

(Fig. 3) with *Amphoroidea longipes* and *Dynamenella huttoni* also occurring regularly in the samples. The highest abundance and species diversity (14 species) was recorded in this seaweed, however several species were present in numbers less than 20. The sample from April 1992 gives the highest specimen numbers and greatest species diversity.

Carpophyllum maschalocarpum

The *C. maschalocarpum* association (Fig. 2) differs from the other three associations being influenced by a different group of species consisting of *Paranthura* sp., *Amphoroidea media*, *Dynamenoides decima* and *Batedotea elongata*. The dominant species was *Amphoroidea media* which had a peak abundance in the August 1991 sample. The subdominant species was *Dynamenoides decima*, with *Scutuloidea maculata, Dynamenella huttoni, Batedotea elongata* and *Paranthura* sp. also commonly occurring (Fig. 3). Only in this seaweed did we record *Amphoroidea media*, *Dynamenoides decima* and *Paranthura* sp. in significant numbers. *Dynamenella cordiforaminalis*, which was present on the other three seaweed species, was absent on this seaweed. The sample from August 1991 has the highest species diversity and specimen numbers, closely followed by the July 1991 sample (Appendix 1).

SPECIES

Two groups of species clustering are evident in Fig. 2 with eight species of isopod consistently appearing. One group associated with *Carpophyllum maschalocarpum* from the sheltered site, consists of *Paranthura* sp., *Amphoroidea media*, *Dynamenoides decima* and *Batedotea elongata*. The other group associated with the three seaweeds from the exposed sites consists of *Dynamenella cordiforaminalis, Amphoroidea longipes, Dynamenella huttoni* and *Scutuloidea maculata. Scutuloidea maculata* and *Dynamenella huttoni* are cosmopolitan in their habitat range. Both are abundant on all four seaweed species and are often the dominant or subdominant species in the exposed seaweeds. *Amphoroidea media* is confined to *Carpophyllum maschalocarpum*, with *Dynamenoides decima*, *Batedotea elongata* and *Paranthura* sp. also largely confined to this seaweed. *Dynamenella cordiforaminalis* is absent from it. We also provide additional evidence of preferences; *Amphoroidea longipes*, along with *Dynamenella cordiforaminalis,* are largely confined to *Carpophyllum angustifolium.* However, the implications of such results are limited without information on the epifaunal contributions from other animal groups; we note that residual collections from *Plocamium costatum* are high in amphipods after isopod extraction.

When a detrended correspondence analysis (DECORANA) is applied to isopod species in relation to algal environments (Fig. 2) significant community clusters are distinguished. Although the pattern and intensity of sampling have not been comprehensive, the data do not give strong evidence of seasonal, numerical or faunal change to a community for each seaweed type. However the isopods show a discrete community structure and species diversity is maintained between the seaweeds at all times.

DISCUSSION

Notwithstanding the very important role of the water column in animal distribution patterns (Cummings *et al.* 1995) the isopod communities of subtidal seaweeds show substantially more structure than a random aggregation of species in transit from an adjacent water mass. Individual seaweed types seemingly provide a physical shelter, microclimate and food source for isopod communities. The results of our work extend the knowledge of isopods (Jansen 1971, Arrontes & Anadon 1990) and other mobile epifaunas generally (Taylor & Cole 1994), and support the contention that at least some species have individual habitat preferences amongst the seaweed types. In Jansen (1971), where we can make direct comparisons, the results are remarkably consistent. The more cosmopolitan habitat range for species like *Dynamenella huttoni* and *Scutuloidea maculata* agrees with the findings of Jansen (1971). Contrary to claims that no idoteid species occurs north of Wellington (Poore & Lew Ton 1993), *Batedotea elongata* is well represented in the epifauna of *Carpophyllum maschalocarpum* at Tapeka. Moreover, records in collections of Auckland Museum show it (and other idoteids) to be widely established in shallow seaweed habitats throughout northern New Zealand. In the northern hemisphere at least some idoteids have been shown (Arrontes & Anadon 1990) to occur specifically with particular macro algae including *Laminaria ochroleuca* and *Corallina elongata.* Further work with local species could be significant.

In the data arranged by correspondence analysis, the sheltered *Carpophyllum maschalocarpum* environment can be clearly distinguished from *C. angustifolium, Xiphophora* and *Plocamium* clusters. If habitat selection was merely a function of shoreline exposure then we might expect the communities of isopods on the carpophyllums to be very distinct, and those of the other seaweed types to match *Carpophyllum angustifolium.* This is not entirely the case. Wave action and substrate are acknowledged by Jansen (1971) to influence distribution, but on intertidal rocky shores, adults and juveniles had significant vertical separation as a direct result of exposure. The less extreme climatic conditions and a means to avoid wave action (shelter between the fronds) might be sufficient to explain why the epifaunas of subtidal environments are not arranged directly according to exposure.

While Taylor & Cole (1994) show that most seaweeds in their study had distinct epifaunas and that algal morphologies play a part in community sizes, they are less explicit on isopod relationships but note in particular that "*Amphoroidea longipes* characterised *Ecklonia radiata*". This example suggests the need for caution in interpreting the finer distinctions of habitat preferences without a knowledge of opportunities by way of other macro algae or algae and substrates in combination. Their suggestion, that wide-bladed thallus construction may provide for preferential settlement of dorso-ventrally flattened isopods as against the tubular ones (cf. *Batedotea elongata*), is not considered by our investigation, though the carpophyllums and strap-like *Xiphophora chondrophylla* communities contained both types. A relationship between density and species diversity in a community (Fig. 3) deserves further exploration but contributions from other infaunal groups need also to be considered.

There appears to be a lack of seasonal influence on seaweed epifaunas. The situation for isopods can be clarified at least to the extent that Jansen (1971) notes that extended breeding and overlapping developmental stages occur throughout the year. While we do not report on size or brood condition, the collections generally reflect a range of stages at all times, but we cannot exclude distribution shifts between adults and juveniles of any one generation. Seasonality may also be reflected through a species compositional change to the community; though this is not evident in our results shown through DECORANA analysis.

In summary, we conclude that the species of subtidal algae support distinct epifaunal communities which, for isopods, have some non-overlapping components. For the algae we have studied this is greatest between two non-contiguous species of *Carpophyllum* and we believe that exposure and substrate play a part in habitat preferences of these epifaunas.

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Appendix 1. Numbers of isopods recorded from four seaweeds at various times, July 1991 to September 1992.

	Jul-91	Aug-91	Nov-91	Mar-92	Apr-92	Jul-92	Sep-92	TOTAL
Plocamium costatum	P1			P4			P7	
Amphoroidea longipes	1	-	-	3	-	-	0	4
Deto bucculenta	0	-	-	1	-	-	0	1
Dynamenella cordiforaminalis	0	-	-	8	-	-	0	8
Dynamenella hirsuta	0	-	-	0	-	-	2	2
Dynamenella huttoni	34	-	-	69	-	-	15	118
Paranthura sp.	0	-	-	0	-	-	1	1
Scutuloidea maculata	50	-	-	333	-	-	123	506
Scutuloidea sp.	0	-	-	6	-	-	0	6
TOTAL	85	-	-	420	-	-	141	
Xiphophora chondrophylla	X1	X2	X3	X4				
Amphoroidea longipes	7	14	1	45	-	-	-	67
Chitonopsis spatulifrons	1	0	0	0	-	-	-	1
Batedotea elongata	0	0	0	14	-	-	-	14
Dynamenella cordiforaminalis	0	15	7	2	-	-	-	24
Dynamenella huttoni	16	24	51	120	-	-	-	211
Dynamenoides decima	0	0	0	2	-	-	-	2
Paranthura sp.	0	0	0	6	-	-	-	6
Scutuloidea maculata	30	55	0	170	-	-	-	255
TOTAL	54	108	59	359	-	-	-	
Carpophyllum angustifolium		A2	A3		A5		A7	
Amphoroidea longipes	-	17	64	-	83	-	38	202
Astacilla sp.	-	0	0	-	2	-	0	2
Batedotea elongata	-	0	0	-	1	-	0	1
Dynamenella cordiforaminalis	-	6	101	-	85	-	161	353
Dynamenella huttoni	-	12	60	-	37	-	43	152
Dynamenella insula	-	0	0	-	6	-	0	6
Dynamenella mortenseni	-	0	0	-	0	-	3	3
Dynamenoides decima	-	0	0	-	1	-	0	1
Jaeropsis palliseri	-	0	0	-	8	-	5	13
Limnoria sp.	-	3	4	-	28	-	27	62
Munna neozelanica	-	0	0	-	6	-	0	6
Munna schauinslandi	-	0	1	-	0	-	0	1
Paranthura sp.	-	0	0	-	7	-	10	17
Scutuloidea maculata	-	67	31	-	250	-	124	472
TOTAL	-	105	261	-	514	-	411	
Carpophyllum maschalocarpum	M1	M2	M3		M5	M6		
Amphoroidea longipes	7	0	0	-	-	0	-	7
Amphoroidea media	55	105	1	-	85	17	-	263
Astacilla sp.	0	3	0	-	0	0	-	3
Batedotea elongata	8	25	13	-	13	9	-	68
Dynamenella huttoni	10	70	20	-	0	0	-	100
Dynamenoides decima	6	0	17	-	59	27	-	109
Limnoria sp.	0	3	0	-	0	0	-	3
Paranthura sp.	65	17	0	-	25	0	-	107
Scutuloidea maculata	82	109	0	-	0	0	-	191
TOTAL	233	332	51	-	182	53	-	